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THE SCIENCE OF CARBONIZATION

SCIENCE as applied to coal carbonization takes many forms. In its most practical aspect it is seen in the design of carbonizing plant to produce the best gas at the cheapest cost from whatever coal happens to be available. This, however, is not the beginning of the story; it is the end. Preceding the design of the plant there must be consideration of the economics of the process. The problems raised by steaming, by mechanical handling, by carburetting and so forth are all concerned with the economics of carbonization. Many valuable papers have been read upon this subject within recent times, and it is perhaps the phase of the subject which most commends itself to the gas engineer who has charge of carbonizing plant. Important as this is, however, it is still not the beginning of the subject; it is the middle; it is a phase which should precede design, but which in this imperfect world must succeed design because, until a new design has been tried out, its economic results cannot be assessed with certainty.

The first stage in scientific carbonization is the analysis of the reactions which take place within the retort. From our earliest days in the Gas Industry we can recollect discourses in text-books, in articles, and in papers on the theory of coal carbonization. Many of these earlier efforts were based upon misconceptions which were later cleared away by scientific research, and it was not until the 1920's that the significance of the plastic layer, of the composition of the coal, and of many other factors, became apparent. The names of those who contributed to this growth of knowledge are written in the text-books, and we shall not refer to many of them here. Among them was Dr. S. R. Illingworth, who recently read a Paper on this subject to the Wales and Monmouthshire Association of Gas Engineers and Managers, an abstract of which is reproduced in this issue of the "JOURNAL." Dr. Illingworth's original work led him to the low-temperature carbonization of coal as being the method of making the best use of coal. The Illingworth retort did not survive for reasons which need not be discussed here, but as is shown from his discourse, the scientific work which he and others did at that time has not been seriously shaken in any material respect—though it has, of course, been extended.

The question that arises from the scientific knowledge which is now at our disposal is whether we have adopted the best possible means to carbonize coal for the production of gas and coke. Carbonization is a method of manufacture which presupposes the existence of a two-fuel industry. There may be two schools of thought as to whether the Gas Industry should concentrate upon gas, or should equally bend its efforts to manufacturing and supplying both gas and coke; but as Dr. Foxwell (himself a pioneer on the scientific work of coal of the same vintage as Dr. Illingworth) pointed out to the Southern Association, the findings of the Fuel and Power Advisory Council make it evident that the Gas Industry for some time to come at least must place as much emphasis upon coke as upon gas. The problem, therefore, that carbonizing engineers and scientists must solve is this: In the light of the known reactions of coal under heat, and of the known reactions of the products of carbonization in contact with various materials and at various temperatures, is the present method of carbonization the best that we can devise, or should we adopt other and more refined methods?

We do not propose to answer this question, because at the moment there is no answer. It is a question that should be propounded to the Gas Research Board. We want the largest yield of gaseous therms of the correct composition and with uniform combustion characteristics. We want a type of coke which shall be ideally suited to the modern appliances which have now been designed. We may require to have more than one type of coke. There are many scientific workers in carbonization who maintain that the only sound scientific method of carbonization is a two-stage process; there are others who believe that the present single-stage process gives satisfactory results and the cheapest products. He would be a bold man who would give a decision between these opposing views, if only because the proper method of carbonizing coal may be one which has not yet occurred to anyone.

Scientifically we have arrived at the point when we know that on being heated to a temperature of about 300° or 350°C. coal gives off gases of very little value, and evolves any water which may be mechanically associated with it. Probably in that temperature range about one-third of the heat required to carbonize coal is used. Is there a method by which the waste gases leaving the retort setting could be brought into physical contact with the coal and accomplish this phase of carbonization purely by waste heat, leaving the retort proper to do the real work of carbonization very much more quickly, with very much less expenditure of heat and at a lower cost? At or about 350°–380°C. coal enters the plastic stage when partial liquefaction sets in, the main reason for which is the liberation and/or liquefaction of the γ-compounds which are soluble in both pyridine and chloroform. It is by no means certain that the reaction is as simple as this, and it must not be forgotten that considerable internal pressure is set up in any coking coal—a point not mentioned by Dr. Illingworth—and that this internal pressure is more likely to be responsible for the formation of a strong coke than the mere presence of γ-compounds, or some other coking constituent, necessary as these are. If the heating is prolonged at a temperature somewhat below about 800°C., practically all the volatile matter can be driven off and the coke will retain ready combustibility; if we preheat the coal by waste gas to some 325°C. before charging into the retort, could we afford to carbonize at a lower temperature, and so prolong the time of carbonization as to produce readily combustible coke by heating the coal for a longer period to not more than 800°C.?

There remains to be considered another important characteristic of coal and coke, and that is the low thermal conductivity of the material. Attempts have been made to overcome this low thermal conductivity, particularly in low temperature carbonization, by using a narrow retort. Even under the best conditions, however, this method does not produce a uniform coke when the retort is externally heated, because the coke against the wall is always lower in volatile matter than the coke against the centre. In extreme conditions it is possible to carbonize coal in such a way that the material against the wall contains less than 1% of volatile matter, whereas that in the centre contains from 10–20%. Some means

of equalizing the flow of heat through the retort is necessary and, of course, the ideal method is to use internal heating. Can a system of internal heating be evolved and applied to the gas retort which will not dilute coal gas by products of combustion or by gases of lower calorific value, and still effect the carbonization at the present cost? It is a problem which many have attempted, but which up to the present no one has solved; it is an opportunity alike for inventors and for the Gas Research Board.

Coal preparation is perhaps the direction in which improvement is most immediately practicable if it can be done on a commercial scale. We have already pointed to the desirability for preheating the coal to effect its drying and pre-carbonization up to the stage when hydrocarbons begin to be evolved in important amounts. It is increasingly becoming the practice at coke ovens to dry coal in a centrifugal machine down to 8% of water before carbonization. This requires no heat and a minimum of power. It is believed in coke oven practice that this 8% of water is evaporated by the flow of gases of distillation up the coke oven so that no additional heat is required. If it be so in the coke oven, it would be equally so in the gas retort; but we have never seen a complete, authentic, and indisputable proof that it is so, and important economies have been claimed on occasion for installations in which coal is dried thermally from 8% moisture down to below 2% before carbonization.

Perhaps the most important stage of coal preparation of the future will be that of blending. The work of G. M. Gill, John Roberts, and their colleagues, together with the experience of R. E. Gibson at the Liverpool Gas Company, and of other workers, has shown that by suitably blending coals, coke of very much improved combustibility can be obtained, and that the process is economic, provided that the coal industry does not try to get for non-coking coals the same price per ton as for gas coals. We look to a nationalized coal industry to rectify this position, and to assist the Gas Industry in coal blending instead of putting handicaps in its way. If the coal industry were to be operated upon modern business methods, it would be prepared to set up central blending plants from which the consumers could obtain whatever characteristics they require in their fuel. This would be of considerable value for boiler work, and would assist the coal industry to dispose of some coals which are now difficult to handle. Central blending plants may well be the answer to the Gas Industry's requirements for coals suitable for each type of retort and for the production of coke of good quality. It may well be that a regionalized Gas Industry will be based for the most part on gas-works large enough to set up their own blending plants. Blending plants are, of course, commonplace in coke oven practice, and there seems to be no reason why they should not equally be adopted in modern gas-works when the works are sufficiently large. The blending plants must apparently be set up at the centres of distribution and not at the collieries, in order to avoid transport charges, and they would have to be controlled by a scientific expert on coals, who would be able to advise the engineers in charge which coals to blend for specific purposes, and in what proportions to blend whatever coals were received.

Finally, in coal preparation the influence of ash must be considered. Coke used in the domestic grate should be as low in ash as possible. Experiments carried out at Tottenham before the war suggested that the quality and quantity of by-products was improved, and the rate of throughput of the retort was considerably accelerated, when the coal was cleaned down to the inherent ash. This is a matter upon which the Gas Industry and the coal industry should have early authoritative information. We are very pleased to see from Dr. Braunholtz's contribution to the discussion on Dr. Illingworth's Paper that the Gas Research Board proposes to investigate this problem of the effect on full-scale carbonization of cleaning coal down to its inherent ash. In our view this problem is of great and immediate importance. A nationalized coal industry, controlled from a central coal board, will have to make up its mind to what extent it will clean coals, it will require to be in possession of authoritative facts as to the desirability and effect of cleaning coals for specific industries, and on that basis it will have to consider what would be the cost of cleaning, and what might be the best method of disposal of the high ash residue lying between true dirt and clean coal.

Dr. Illingworth's Paper is an excellent restatement of scientific principles which have been known for the past 20 years. These scientific principles do not appear to have been restated to the Gas Industry recently, and Dr. Illingworth has done us a service in reminding us of them. It is necessary for the engineers and scientists of the Gas Industry to consider afresh in what way these scientific principles can best be put to practical use.

A Prayer

Most evenings our daily rut leads us past one of the more charming Mrs. Mops of Farringdon Street, who sometimes looks blank, sometimes looks furtively around before producing from a camouflaged store a copy of the *Evening News*. On the barren evenings we try again at a main-line bookstall, pleading with stern good humour across a counter weighed down with snob papers, semi-salacity, Good Works, and threepenny bloods, and go on our way thinking how grand it would be to devote a few reams of the snob art paper or three-halfpence worth of the "blood" to our old and reputable pursuit of serving the Gas Industry.

Almost daily, too, we read on the subject of newsprint questions in the House, challenging statements by the Big Press, or adroit answers by Ministers; and we are left with a vague hope of slight benefits to come (since all the world seems to think they ought to be granted), but with no definite information which might allow us to map out our return to a pre-war standard of service. May we, Mr. Minister, add our humble prayer for relief from bondage, aligning ourselves with those who press the claims of education to support their plea for more paper? It is for so little we ask—probably not more in a whole year than the weight of forms filled in daily by the building contractors of the Metropolis.

During the last three years millions of copies of a fortnightly pamphlet entitled "The British Way and Purpose" have circulated among the Armed Forces. The object has been to teach the responsibility of the citizen. Well, our British way and purpose have put into undisputed power a Labour Government whose purpose is (the way is not yet known) to nationalize the Gas Industry. It is a biggish proposition, involving as it does some 12 million consumers, £250 millions of capital, 75,000 workers, 21 million tons of coal a year (apart from the Gas Undertaking, which closed its showrooms rather than extend its gas-making plant); yet the Technical Press, whose function is to inform and educate the Industry—and those who will manage the Industry, and those who, though they probably don't realize it, will own the Industry—is restricted to a consumption of 28½% by weight of its pre-war paper.

An Exhortation

Is it realized what this means when it comes down to actual pages, thinned and trimmed as they are? In 1939 it can be said that an average "GAS JOURNAL" contained 80 pages, of which 35 pages were devoted to technical articles and reports and 45 pages to advertisements. Thus, apart from special numbers, we were able to cover the whole technical and political life of the Gas Industry. What is the present position? With meticulous care and close consideration of our claims our quota of paper for the four months March to June has been fixed at 114¼ cwt.; and by strict economy we can print 48 pages a week—14 of text and 34 of advertisements. Those are hard facts, and they make it very difficult for us to do our job. As we buy our fourth "pending" tray (pressed tin, price 9/6) for the editorial desk, we think of the forthcoming meeting of the Institution of Gas Engineers, which in the old days would have provided us with some 200,000 words of concentrated wisdom, but whose proceedings nowadays we are bound to leave in almost Olympian seclusion.

Some greater freedom must come. And so, authors and secretaries, will you bear with us; and you, subscriber on the waiting list, will you borrow a little longer? Will advertizers and their agents have patience with our colleague upstairs as he blue pencils every fourth insertion of a contract, and realize how it stuck in his commercial gizzard to ration out of existence no less than 10 pages of advertisements every week in 1945? And will you, Mr. Shinwell, put in a word for the Technical Press, so that those who work in the vast realm which you intend to control may be fully informed of your plans, equipped with the latest knowledge, and on their toes, make a good job of the British way and purpose?

Personal

Back in this country after twelve years' service in Hong Kong is Mr. F. TYNDALL, Assistant Engineer and Manager of the Hong Kong and China Gas Company.

* * *

Mr. P. WALLIS, recently demobilized from the R.A., will represent Smith Meters, Ltd., in the Midland Area, and hopes to uphold the traditions of his predecessor, Mr. R. E. TREEN, who is relinquishing the area for health reasons.

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On his retirement atter 18 years' service as Engineer and Manager of the Spalding Gas and Water Department, Mr. J. DEMAIN was the recipient of a presentation from his colleagues at a recent meeting of the Spalding Urban District Council.

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Mr. I. MARSHALL, A.C.I.S., of the Bradford Gas Department, has been appointed Chief Clerk and Commercial Assistant to the Loughborough Gas Department in succession to Mr. G. F. ONIONS, who will shortly be retiring from the position after a service of 47 years with the Department.

* * *

Mr. T. B. SCOTT has been appointed Secretary of the British Gas Council as from June 1. Mr. Scott is 33 years of age, and is at present Statistician and Accountant to the Association of Drop Forgers and Stampers, prior to which he was an Administrative Officer and Statistician at the Admiralty. Previously he held appointments with Sterling Industries Ltd., Electrical and Musical Industries, Ltd., and Electrolux Ltd.

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Mr. W. MORLAND-FOX has been appointed to the Board of Directors of W. J. Jenkins & Co., Ltd. Educated at Edinburgh Academy and Glasgow University, Mr. Morland-Fox served his apprenticeship with the British Thomson Houston Company. Following his apprenticeship he joined West's Gas Improvement Company in 1923 as a member of the Erection and Operating staff, which post he held for 10 years. In 1933 he joined W. J. Jenkins & Co., Ltd., as London Manager, and this post he held to the outbreak of war, when he went on active service with the Royal Engineers till the war ended. Prior to this he had from the outbreak of war in 1914 served in the Royal Flying Corps and the Royal Air Force until that war was finished.

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Major J. LACHLAN STURROCK, late Royal Engineers, has been appointed by Messrs. E. Boydell & Co., Ltd., manufacturers of Muir-Hill dumpers and shovels, as their representative for the Midlands, South-West England and Wales. While with the Royal Engineers Major Sturrock held a number of important technical posts dealing with earth-moving machinery. These included instruction of Royal Engineer personnel, technical investigation into uses and application, design and development of new types of this machinery before and after the invasion of France. During the past two years he has been closely associated with the Road Research Laboratory in the research work covering the development and post-war application of road-making machinery. Reports of some of his investigations are shortly to be published.

Obituary

Mr. R. L. MERRY, formerly Managing Director and Secretary of Holbeach Gas Company, has died at the age of 75.

* * *

The death has occurred of Mr. ADAM C. FINNIE, Engineer and Manager of the Melrose Gas Company. A native of Leven, he was 51 years of age and served his apprenticeship with Henry Balfour & Co., Ltd. Before going to Melrose he was Manager of the Duns Gas Company. His father, the late Robert Finnie, was associated for many years with the production of gas-works plant at Durie Foundry.

Letter to the Editor

National Fuel Economy

DEAR SIR,—In your issue of May 8 you published a Paper by Dr. G. E. Foxwell on the place of the Gas Industry in the national fuel economy. It is a most interesting Paper, and with much of it we cordially agree.

We think, however, in the light of past history, it is scarcely wise to recommend that the whole of the carbonization industry and the manufacture of smokeless fuels should be handed over to the Gas Industry. They were given the opportunity somewhere about 1927 of experimenting with low temperature carbonization, and were given a grant of £100,000 in order to help them. In spite of this and the valuable assistance of the Fuel Research Board of that time, the whole project was a dismal failure and the money was lost.

It does not follow that a specialist in one industry is necessarily a specialist in another and quite different branch of an allied industry.

Yours faithfully,

LOW TEMPERATURE COAL DISTILLERS'
ASSOCIATION OF GREAT BRITAIN, LTD.,
W. A. BRISTOW (*Chairman*).

82, *Victoria Street*,
London, S.W. 1.
May 13, 1946.

Diary

May 23.—Lancashire and District Coke Association: Annual General Meeting, Grand Hotel, Aytoun Street, Manchester, 11.30 a.m.

May 25.—Scottish Junior Gas Association (Eastern District): Annual General Meeting, Dunfermline.

May 28.—Women's Gas Council: Annual General Meeting, Gas Industry House, 3 p.m. Speaker, Viscountess Davidson.

May 28.—Southern Association of Gas Engineers and Managers (Eastern District): County Meeting, Southend-on-Sea.

May 28.—Domestic Development Committee: Gas Industry House, 2.30 p.m.

June 1.—Midland Junior Gas Association: Ladies' Day, Cheltenham.

June 4–7.—Institution of Gas Engineers: Annual Meeting, London.

June 12.—National Benzole Association: Annual General Meeting, Wellington House, Buckingham Gate, S.W. 1, 3.45 p.m.

June 15.—Scottish Junior Gas Association (Eastern District): Annual Outing, Edinburgh; visit to Granton Gas-Works.

June 15.—London and Southern District Junior Gas Association: Summer Visit to Bournemouth.

June 21.—Waverley Association of Gas Managers: Edinburgh, 10.30 a.m.

June 22.—Manchester and District Junior Gas Association: Ladies' Day. Morning, visit to Lancaster; afternoon, visit to Morecambe.

June 26.—Southern Association of Gas Engineers and Managers: Summer Meeting at Maidstone.

The B.G.C. at Leicester

Members of the British Gas Council were the guests of the City of Leicester Gas Committee at a luncheon held in the Art Gallery at Leicester on May 14. This luncheon and the meeting which preceded it were the first provincial gathering of the British Gas Council since its formation last year.

Mr. A. E. SYLVESTER, Chairman of the British Gas Council, expressed great pleasure in his task of proposing a toast to the City of Leicester. He said that but for the war the British Commercial Gas Association would have held its annual meeting and conference in that city six years ago, and that it was fitting on this occasion that he should take the opportunity on behalf of the Industry as a whole of thanking the Chairman, Councillor S. J. Perry, for so kindly remaining in office through those years. He felt he must make a short reference to Mr. Mitchell, under whose management for a number of years the City of Leicester Gas Department had grown and progressed, and now stood high in the ranks of the Industry as an organization giving very good service, and helping to keep to the front the claims of gas in its service to the community. He went on to say that, speaking as Chairman of the British Gas Council, which was set up last year because of the urgent and ever-growing need for unity in the handling of national affairs on behalf of the Industry, he felt the new Council had already justified its existence, and that its policy of trying to build up stronger and more effective district organization rather than emphasize too much the centralization of things at headquarters was a very wise one. He added that in spite of the fact that present controls and restrictions prevented the Industry from going ahead as it wished, they must never give in or take the view that anything was too difficult, but must try to improve the service that they in the Gas Industry gave to their consumers. By doing that they would lay up stores of goodwill—that biggest asset in any balance-sheet—which would enable them to take advantage of the tide when it turned.

The MAYOR, Councillor C. E. Worthington, said it was a great honour and privilege for him to reply on behalf of his City, and that he had a good deal of confidence in the future of the Gas Industry.

Councillor S. J. PERRY, Chairman of the City of Leicester Gas Committee, and President of the British Commercial Gas Association, proposing a toast to the guests, said his first obligation was to extend a very hearty welcome to the City, and to express his gratification at the very generous way in which his invitation had been accepted. He also wished to thank the Mayor and the Committee for the facilities they had placed at his disposal.

Colonel H. C. SMITH, Chairman of the Federation of Gas Employers, replying on behalf of the guests, said they were very grateful to Councillor Perry for acting as Chairman of the British Commercial Gas Association during the war years. He wished, too, to pay a tribute to the workpeople employed in the Gas Industry during the war years, who had carried on often under conditions of extreme danger, and so ensured that the consumer was always kept supplied.

After the luncheon a visit was paid by some of the guests to the works of Taylor, Taylor & Hobson, where they were shown the whole procedure which goes into the making of lenses of all sizes. This firm has been established for 60 years, and manufactures the lenses used in technicolour films.

Illuminating Engineering Society

The Victory Convention of the Illuminating Society was held May 14–16 and, in addition to a full programme of addresses, visits, and social events, the occasion was marked by an exhibition. Held at the Institution of Electrical Engineers, this consisted of numerous exhibits staged by the Services, Government Departments, and anonymous manufacturers, and showing many of the lighting methods developed during the war. Searchlights, a viewing range for naval camouflage, an aircraft cockpit, and a wide range of photometric equipment were among the many interesting things to be seen there.

The annual general meeting took place at the Institution of Electrical Engineers on May 15, when the chair was taken by the President, Mr. H. C. Weston. The yearly report was summarized by the President, who said the past year had been an unusually successful one and that 266 new members had joined the Society, the membership of which now totalled 1,853. The meeting gave him particular pleasure, as he was handing the presidency over to Mr. J. S. Dow, whom he had known for 20 years, and who had held the office of Honorary Secretary since 1928. Sir JOHN PARSONS, one of the first presidents of the Society, then paid tribute to Mr. Dow's long service, and recalled that they were both present at the Society's inception in 1909. Mr. Dow had worked continuously for the welfare of the Society and had not missed a meeting for 37 years. It was largely due to his efforts that the Society had not faded away—a fate that had befallen so many—but had advanced and prospered. Mr. J. S. Dow was then presented with an address and other gifts. In thanking the speakers and the Society, Mr. Dow said that he had known no other body in which the members so worked together, and that he hoped always to be associated with them.

In the course of the meeting it was reported that Officers for the forthcoming session would be as follows:

President.—J. S. Dow.
Vice-Presidents.—J. M. Waldram, N. V. Everton, J. S. Preston.
Hon. Treasurer.—P. Good.
Hon. Secretary.—H. C. Weston.

The first of the addresses which followed was presented by Mr. Percy Good. Entitled "Lighting During the War and After," it described the work done by the various committees upon which Society members had served. He paid special tribute to the work of Sir Reginald Stradling, who had done so much to convince the Government that ordinary workers outside the ministries could be entrusted with the nation's vital secrets. Many problems had been tackled and solved, and extensive research work was carried out to render a blackout system for the country which, while exhibiting as little light as possible to the sky, provided sufficient illumination to reduce accidents to a minimum. Star lighting was evolved, and eventually 7,000 miles of streets were lighted by this method. Experience showed that wet roads were less visible than dry ones, and with the help of the Westminster City Council many experiments were undertaken with the aid of water wagons, &c. Experiments in the G.E.C. laboratories proved far more satisfactory than field tests, and here many of the inventions devised by well-meaning citizens and often sponsored by M.P.'s were tested; most of these proved useless. The Committee also experimented with underwater lighting for decoy purposes, and produced apparatus for erection in country districts to imitate the lights of an industrial town. Looking to the future, Mr. Good emphasized that economy in street lighting was not a public service, and advocated the lighting of parks and the flood-lighting of notable buildings.

Dinner and Dance

The evening of May 15 was marked by a dinner and dance held at the Connaught Rooms, Great Queen Street, W.C. 2. The chair was taken by the President of the Society, and over 350 guests were present.

Proposing the Toast of "The Illuminating Engineering Society," Mr. G. TOMLINSON, Minister of Works, recalled the work done in past years by the President in improving lighting conditions in the cotton industry in Manchester, in which he himself had grown up. He had had connexions with both electricity and gas committees, and in reconciling the irreconcilable the Society had claims as budding politicians. He mentioned the recent improvements in factory lighting, and stressed the effect on life of a well-lit home. It had been suggested that one of the objects of the Society was improved lighting without garishness. In this and all other matters the Ministry of Works was anxious to co-operate. Co-operation was a two-way traffic, and led to the development of confidence in each other.

Responding, the PRESIDENT regretted the lapse of such social events during the war years; he was thankful we had not forgotten how to enjoy ourselves. During the war the Society had been concerned with low illumination due to the advent of the meagre pittance of light in the streets by night, but it had been necessary to ensure the installation in factories and vital buildings of very efficient light sources to provide the high standard of lighting necessary to sustain public morale. For these purposes the fluorescent lamp—a British invention—had proved invaluable. Leading members of the Society had served on factory, street, and road traffic sign official committees as well as on research work for fighting personnel. Their suggestions had been adopted by the ministries concerned, and there had been admirable co-operation between members. Good lighting was not so simple as some might suppose. Behind the best modern lighting practice lay much research by members. The term "lighting engineer" was hardly apt, for he must concern himself with architecture, town planning, and similar subjects as well as the purely engineering aspect. The demand for good lighting was growing among the public, and it was now a statutory requirement—a far cry from the discouragement of 100 years ago when there was a tax on windows. He was confident that the future offered ample scope to the Illuminating Engineering Society.

"The Guests" was in the hands of DR. C. C. PATERSON, a past president of the Society, and the response was by PROF. E. N. DA C. ANDRADE.

Another War Effort

We have published recently several accounts of the work done by leading manufacturers connected with the Gas Industry during the war. We may now add another name to the list. Becoming a controlled undertaking on the outbreak of hostilities, and subsequently carrying out work for the Ministries of Aircraft Production and Supply, Keith Blackman, Ltd., have good reason to be proud of their record. Long well known in times of peace for their volume and pressure fans and air heaters, filters, and washers, this firm specialized in similar instruments for vastly different purposes in wartime. Tanks were equipped with propellor, centrifugal and axial flow fans for cooling the engine radiators. The American "Sherman" tank and adaptations of them which were used in the Far East where the atmosphere renders their operation almost impossible were fitted out with air-conditioning and cold air douche apparatus for the crews. Considerable research was necessary for this purpose, and the finished equipment was tropically treated and specially packed for shipment. Ventilation apparatus for mobile laundries and multi-stage turbo blowers for mobile bakeries were among the many designs supplied to the army.

The Air Force also benefited from Keith Blackman products, and used large numbers of high efficiency fans for blowing up new balloons with air for testing, while high efficiency air blowers and gas boosters were used in pairs—one air, one gas—for generating hydrogen for the balloons. Fans were also used for aero-dynamic research, de-icing aircraft engines, and played a part in the saga of jet propulsion. Electric motors for searchlight remote control and designed to ensure that the beam was in sympathy with the radio-location equipment, fabrication for gliders and "Albermarle" bombers, and compressors for radar experiments were also supplied.

Perhaps one of the most interesting of the KB wartime products was the motor which they designed and produced for the "midget" submarine. This supplied all the motive power when the vessel was submerged, and also the necessary power for the ventilation of the craft. Another type of apparatus designed for and in collaboration with the Navy was a fan booster for use on convoy barrage balloons, and many hundreds of these units were supplied. Fans were supplied for many purposes, such as the provision of air blast to oil-fired galley stoves in battleships, the ventilation of the holds of transport ferries when in harbour and of destroyer engine-rooms. Searchlight projectors and signalling shutters for naval landing craft, buoys and pawl locks for boom defence, and many other vital types of equipment were also made.

Among the other varied products may be mentioned light-traps for buildings, soldering irons, compressors for gas mask testing, and fans for the ventilation of factories and air raid shelters, and for drying grain and flax.

Half the Houses to be built by West Hartlepool Corporation are to have gas cooking and washing facilities and the other half will have electricity.

Darlington Corporation has decided that 50% of the houses built for the Council should have gas cookers. All houses will have gas boilers. There will be a maintenance charge of 1s. 6d. per annum for gas cookers and boilers.

"Women's Magazine," a B.B.C. feature which is broadcast to India weekly, has, it is claimed, the largest potential listening public in the world. A recent broadcaster in the series was Miss Esta Eldod, Public Relations Officer for Radiation Ltd. Her subject was "Public Relations as a Career," and she stressed the necessity for keen observation, and the ability to anticipate the trend of current affairs. Speaking of her own work she gave some details of the link-up of gas and smokeless fuels in the post-war housing programme.

Regionalization and the Heyworth Report

Address* by Dr. E. W. SMITH, C.B.E.

DR. SMITH emphasized first that it was necessary to discuss the matter from the point of view of what was best for the Industry, without any reference to preconceived ideas.

The more discussion there was of the matter, so long as it was constructive, the better. However good a Ministry might be, it was there to administer and not to create. He had not the slightest doubt that the Ministry of Fuel and Power Gas Division, and the Ministry itself, would welcome assistance, either officially or otherwise. They were getting it officially from the Advisory Committee which met the Minister regularly. But even the Advisory Committee should to some extent be disciplined by hearing the views of the Industry as a whole.

The primary reason why the matter should be discussed was that so many factors had to be taken into consideration that it was not possible for any one group of people to know it all. For instance, one admired the very great step that had been taken by the Gas Light & Coke Company in its recent reorganization. They were essentially a region to themselves, and they were showing what could be done in the proper organization of a region from the points of view of control, decentralization, and the like. They had learned from the mistakes of other big undertakings.

They did not need to worry a little bit about the future of the Industry except in so far as it might fall short of what it might be. The Industry would be successful, whatever big mistakes were made, because it was essential; it was going ahead. The war had shown that, in spite of all the limitations that existed, it was a growing force within the community.

Prior to the war a great many had felt that there was room for a radical change. There were weak spots in the Industry; and the opportunity to note those weak spots was given to the Regional Advisory Boards, which he had had the privilege of bringing into existence. Those Boards had been astounded by the conditions they had found in a large number of undertakings.

Giving two instances of bad conditions in comparatively large works, he said that one of those works had been short of gas about four years ago, and the Gas Committee had asked for assistance. An inspector who was sent down had found that 75% of the gas plant on the works was not in use; it had never been repaired, and it was not fit to use. The remaining 25%, on which the works had depended, had consisted of horizontals, and they were working without retort house governors and without meters. The Gas Committee had thought that everything in the garden was lovely, until there was a shortage. Then one man was put in, and in the course of a month 75% of the works was on full output, having been put into good shape.

The Question of Salaries

Why should the Gas Committee have known that there was anything wrong? They were drapers, butchers, solicitors, and others, who had no knowledge of engineering, and who had kept salaries down. The man in charge was well worth the money that he was paid, and was worth more, but the Committee ought to have been paying three times as much.

Another works, which also belonged to a local authority, could not supply all the gas that was wanted. The works were bought from a private company some years before, and the Gas Committee had appointed an engineer, so-called. The distributory system was in chaos; there were no showrooms and no service department. A price was offered by a holding company, and the local authority were about to accept it because it was £1,000 higher than the price offered by another undertaking quite near. All parties were brought together at a meeting. When the Mayor was asked whether the objective was to make more profit or to give a better service, he had replied that he wanted a good gas undertaking. Within a month his town was taking gas from a nearby town (there was a high-pressure main within a quarter of a mile) at the same price as in the larger town, and within two years the output had increased by more than 100%.

Those were major and obvious deficiencies. Some 40% of the Industry consisted of undertakings owned by local authorities. There were some good local authorities, but how many local authorities were there to-day, particularly in the industrial north, in which the engineer led a dog's life because the members of his Committee obtained all their reports from the workmen in the retort house and in the yard, and where the members of the Committee knew more details of what was going on at the works than did the engineer himself? That would not happen in a normal company organization. In his view it was wrong for local authorities, with their local control, to have anything whatever to do with the running of a trading organization. He held that view in spite of having served for 10 years with an important local authority, and with a detailed knowledge of what could go on under local authority control.

Unfortunately, that was the type of control which, without thought, the present Government strongly supported. They believed it was democratic. Well, it was wrong!

Group Control

Regionalization would possibly mean closing small works here and there and connecting up other works; but he did not believe that was of major importance in connexion with regionalization.

The important factor, in his view, was that there should be co-ordinated control in larger groups, and that that control should be with very highly experienced specialists who would give guidance and assistance to the managements of individual undertakings in connexion with production, distribution, sales, service, or anything else. It was not possible for undertakings below a given size to handle such matters efficiently, except in collaboration with other undertakings, and that could not be done in a voluntary way; it had to be done in a systematic, authoritative way from the top.

In that connexion Dr. Smith mentioned another case of deficiency, which was the cause of the initiation of the Advisory Boards of the regions. It concerned a small private company undertaking in the Midlands; it was short of gas, and could not get results. A large undertaking loaned some foremen. The Board of the company were astounded to find that their engineer was not quite up to the position, and they had resented any suggestion that there was any deficiency. But the salary that was paid to the engineer had more than justified the deficiency; if they had paid three or four times as much, the position would have been very much better.

Coming back to local authority control, he said that another defect was the preponderating influence of the town clerk. In most cases the town clerk was really the general manager of the gas undertaking; his salary was the standard for salaries in the area, and it was impossible, however much there might be a need for a better man at a higher salary as engineer or manager of the undertaking, to obtain for him a higher salary, or anything like as high a salary as that of the town clerk. The latter was usually an extremely good town clerk, but a very bad Gas Engineer and a very bad manager. He butted in, however, and his advice was taken always in preference to that of the Gas Engineer, and the status of the two was such that we could not expect anything else than that the Town Clerk's view would be accepted.

"Safe Advice"

In connexion with the development of regionalization and the advice which the Minister expected to obtain from various quarters, Dr. Smith urged that one of the biggest problems to-day was to determine just where safe advice could be obtained. He surmised that the greatest competence in gas engineering and administration in Great Britain or in any country to-day, was to be found in the Gas Light & Coke Company. But looking at the Industry as a National Industry, in which the requirements and the essentials of different areas varied so much, the last people who should take control or who were the only people to give advice would be such experts as the Gas Light & Coke Company's officials. That was a compliment; but it meant that they were not in touch with the weaknesses of other parts of the country. They would hardly believe it possible that there were such weaknesses. What was needed was to combine the advice from that and similar quarters with the advice from those in other parts of the country who were prepared to discuss the problems openly and with a free mind, without feeling just where their individual and personal interests were going to be affected.

For instance, the solution of the general problem of what was good for the Gas Industry in its regionalization could not be assisted by taking advice from a company which obtained all or most of its gas as coke-oven gas, because their circumstances were peculiar, and naturally there were certain interests which they required to protect, which interests were entirely different from the interests of the Gas Industry as a whole; so that one of the biggest problems was to know just how the Minister could get to know the conditions that had to be met, without sending a number of junior Civil Servants around the country quizzing. It could be done.

The Voice of Authority

We were satisfied that from a national service point of view the B.C.G.A. and the National Gas Council had enough authority. Were we satisfied that, if they were to pull their weight—on the assumption that they were to continue and, if not, that the British Gas Council would take their place—they could represent to the Minister as such what was required for the Industry as a whole to-morrow? Were we

* To the Southern Association of Gas Engineers and Managers, May 7.

satisfied that in the past any of those older bodies had ever been able to function as we should like them to function, in view of the fact that every gas undertaking was an entity to itself and had to get things agreed by its committee or board, and consequently all that could be done was to give advice? Perhaps 80% had joined in, and 20% did not follow the advice given. Consequently there was chaos in certain areas because of differences in policies. We wanted the authority to be given to the national body, within certain limits.

Regionalization, on the recommendation of the British Gas Council and the Heyworth Report, was agreed. But he felt very strongly that regionalization could not be a success, or could not be the success that it might be, unless there were a National Gas Board which co-ordinated the regions. Inevitably there would be overlapping; there would have to be adjustments, and all kinds of national problems would arise, such as education, research, buying, and in many other directions. There should be some form of overriding advice, but to some extent direction and control, it being understood that the regions would, within very wide limits, be in charge of their own functioning. Probably the National Board might very healthily have functions similar to those of the old Board of Trade, which were never very irksome to the Industry; but it would function with knowledge and experience, consisting of experienced, knowledgeable people from the Industry itself, running the Industry as a national enterprise.

A further point of very great importance was that, if there were a National Board, we must watch very carefully what happened in the final arrangements made in connexion with other industries, such as coal. It was vital that the National Board should be responsible directly to the Minister, and not to the Ministry; it should be like a Department of the Ministry in that respect. It was not of the slightest use that it should be responsible to a Ministry which could have its own staff—engineering, research and the like—giving constructive thought to the future of the Industry, whilst at the same time as a National Board it was doing the same thing. Inevitably there would be a difference of view, and the Minister would be influenced by his own staff mostly; only in very exceptional cases would he take up a position different from that advised by the Civil Servants. Civil Servants were excellent in their place; there was no one finer. But they should have nothing whatever to do with anything but the major top policy of administration, not of execution. "We can do the execution."

Holding Companies

The formation of the holding companies represented a step in the right direction, a definite advance. But a map of Great Britain, showing all the holding companies, would indicate that in very few cases were they co-ordinated with each other so that they could do the best for the British Gas Industry as a whole. One company holding would be found as an island in the middle of another company holding, and the like. When doing things in that way in competition, finance was not readily available; chances could not be taken; developments which would otherwise be essential had to be postponed, and we were not getting the best out of that form of regionalization. That backing could be made better. It did require direction from above as to the form and extent of the holding companies. In effect the Heyworth Report recommended ten holding companies of co-ordinated undertakings in various areas; it was really an extension of the holding company idea.

Not only should there be regionalization, but the regions should have a co-ordinating body at the head, corresponding to the electricity commissioners, or run on similar lines to the Port of London Authority, adjusted to suit the Industry. But it was essential that there should be unity of financial control, which meant that the undertakings would have to be taken over or bought out. In that connexion we should have to watch what happened in the coal industry. One of the most unjust things that could happen to the shareholders—and they had to be considered fully—would be to buy them out in Government stock which was not negotiable. The stock must be negotiable and saleable through the Stock Exchange in the open market, as was any other gilt-edged security. If that were not done there would be brought about a tremendous injustice connected with a very large number of modest, financially-responsible people. The stock of gas undertakings was held to a very large extent by small men, people with a little who had gone for security and safety, and if it were not negotiable at death on a market value there would be a definite injustice.

Education, Research, Welfare

Regionalization made possible a national education scheme. He did not think anyone was satisfied to-day with the education scheme in the Gas Industry, whether it be for gas engineers or any other type of personnel required by the Industry. The reason we were not satisfied was that there were so few entries. A few undertakings handled their own education schemes extremely well; it was upon them that the industry would depend for some years to come. But, taking the country as a whole, the Industry's education scheme was not appealing to enough men and youths. The chief reason was that facilities for education were not available. He felt that if we had a National Board and regionalization it would be possible to have, with the Board of Education, a properly co-ordinated education scheme for every phase of the Industry?

The same applied to research, which would be a matter of national concern. There should be research, and there would be possibilities of development as a separate item from research; the research could be elaborated in a very much more extensive way than it had been to date, and we could do something which was worthy of the Industry. All that had been done had been thoroughly worthy of the Industry, but the amount was negligible as compared with what it should be in an Industry of such a size.

Again, with regionalization on a national basis there could be proper welfare, proper arrangements for staffing and the interchange of staffs. What was more pitiable than to go into an apparently very well run place and to hear people saying how badly the rest of the country was being run. The parochialism in the Industry was terrible; the position had become better than it was, with regional committees which understood each other's problems, but in some places people had almost to fight to be allowed to go and see what was going on elsewhere. That would be improved. So that regionalization had sold itself.

Personnel

He felt that there would be a radical change in the functions of individual personnel; there must be. Was it reasonable to expect that one man, the head of a medium-size undertaking, not big enough to keep a chemist, a first-class accountant, and so on, was really competent to give the highest efficiency in his undertaking when everything devolved upon him? Of course it was not.

In the organization under regionalization the man in charge of a works would be a production engineer. The regional chief engineer would use him and his experience to determine when repairs were required, when new plants were wanted, what types of plant were to be used, what new experiments were to be carried out, and the like. One assumed there would be a separate organization for sales, with service, accountants and the like, controlled from the region. And, of course, if the senior men behaved in the decent way in which most of the Advisory Committee men behaved, there would be no indignity in having a superior authority above, because if the senior men, the co-ordinating engineers, were selected properly and gave the right direction and advice before they started functioning, they would make the lives of those working under them happy and contented, with scope for improvement, but in a slightly different sphere. There was plenty of room for all the good men at present in the Industry, and it could probably do with an increase of 50%; it was up to the Industry to see that that extra 50% was obtained as soon as possible.

The technicians' duty was to see that the best was obtained out of any organization that might be evolved. But the supply of gas at the lowest cost would not be provided to the consumer unless those having the requisite knowledge and experience were allowed to conduct the Industry's affairs. The threat of nationalization did not need to stultify their activities. The Gas Industry was in a very different position from that of the steel industry, cable and wireless, and so on; it was already a national utility.

Had the Government been wise they would have taken nationalization in steps, starting with the most promising first—*i.e.*, gas and electricity—and would have made a job of those and so proved their case. Then, as they became experienced, they would have taken on other industries. But they had not done that, and he only hoped that engineers and technicians would not worry about the threat of nationalization. They were in a very different position from that of other industries; they had no export, and they should carry on as though there were nothing whatever in the wind. He was certain that those undertakings which behaved in any other way, which held back progress and did not make the developments they would normally have made if nothing were happening, would be very sorry when the time came for them to be taken over and evaluated. He knew that the Ministry was authorizing all progressive schemes which were for the good of the Industry as a whole. Work was going on that would occupy 5, 6 or 7 years, and if those who were thinking of further developments would take their courage in their hands and go ahead and make their recommendations, that 5, 6 or 7 years might become 10, and they would be pleased when the time came for the evaluation of their undertakings that they had done so, because they would be given full moral and financial credit for it.

DISCUSSION

Mr. J. H. Dyde (Uxbridge) said that when at times he felt the situation with regard to the policy of nationalization unpalatable, he consoled himself in the belief that State ownership would ultimately have emerged from the political development of this country. He had in mind the four-year plan put forward by Mr. Churchill before the cessation of hostilities, when he had said words to the effect that certain of our basic industries were ripe for State control. Mr. Dyde's guess as to the industries Mr. Churchill had referred to would be the public utilities, whose saleable energy was derived from our only indigenous raw material of any value. Why, the Industry had asked for a Ministry of Fuel to co-ordinate the fuel resources of the country. Was not that a first step, and one taken by the Industry?

Coming to the Heyworth Report, which was not prepared by Socialist nominees, he said that a long-stated and nebulous series of ideas put forward of the advantages of regionalization, giving rise to a defined decentralization, were given concrete form in the Report; and though boundary queries might be expected to arise from any division of the country, they could not be serious.

The Report's proposals as to the qualifications of the members of the Regional Boards were as good as any other suggestions he had seen advanced, though perhaps it would have been a good thing to have stipulated that one member must also have had experience as a business accountant or statistician, in the same way that Boards of Directors of private companies usually included a financial expert, and municipal undertakings had the City or Borough Treasurer as adviser.

But he was concerned to ask where the ordinary practising gas engineer and manager came in. The Report stated that: "Selection of personnel taken over with absorbed undertakings for positions in the new structure to be strictly on merit, and the Board have powers to pay compensation to personnel not retained." That was good enough, perhaps, on the face of it; but merit was going to take a lot of assessing, particularly where members of the Board had no personal knowledge of the individual concerned. The state of a company or undertaking was not necessarily a function of the ability of its engineer and/or manager. For instance, Boards of Directors had not always followed the advice of their officials, and legacies had been inherited which only a long term of good management and direction could rectify.

The Unions had always stressed, in their dealings with employers, the "better conditions" clause. Mr. Dyde suggested that the officials in the Gas Industry should also seek to apply that principle, so that an official would not be worse off under the new than under the old regime. In the vast majority of cases his attainment of a position of responsibility with commensurate salary had been achieved through merit, and his standard of living thereby fixed. If under regional integration some of his responsibility were divested from him, he should not suffer financially; and if in the extreme case his services could not be retained, compensation should be clearly defined on a just basis.

Discussing Para. 163 of the Report, he said it was perhaps unfortunate that the scientific qualifications desirable in an executive officer on the manufacturing and supply side of an undertaking should continue to be described as "gas engineering."

Carbonization, purification and treatment of by-products, &c., were chemical and physical processes common to many branches of the chemical industry. Therefore, there was no need for a narrow and specialized form of training. He believed that that was the point which Dr. Smith was getting at. The Industry offered scope in the widest sense for chemical technologists and chemical engineers. The Gas Light and Coke Company had given a lead in that matter in their recent divisional and works engineering appointments.

As to the recommended standards of gas quality, &c., whilst perhaps none could disagree with the aims in the permissible limitations of divergency of calorific value, specific gravity, sulphur content and pressure conditions, as providing desiderata for improved service to consumers, the practical application and the cost involved had not been given a thought in the Report.

As to the calorific value, the $\pm$ 3% variation was not onerous, provided undertakings could receive the descriptions of coal for which their plant was designed. That was particularly so in the case of smaller undertakings relying entirely on verticals—which were as sensitive as a thoroughbred, and which from the carbonizing point of view they were. If, therefore, no guarantee could be given as to the future of supplies, time must be afforded to put in adequate balancing plant.

Under present conditions the $\pm$ 5% variation of specific gravity would be difficult to attain. A coal shortage and a Government edict to manufacture maximum C.W.G., and one was immediately off the rails.

As to the 10-gr. limit on sulphur, if sulphur extraction were to be practised, as it should be with the greatly increased use of flueless heaters, why not a lower limit?

In his view the installation of service governors or individual appliance governors should not be made a compulsory condition. From experience with several companies, he said there were wide distributing areas, properly mained and subject to controlled pressure, where such a measure was not necessary, and would be a waste of money which must come from the consumers' pockets. On the other hand, there were areas, as exemplified by the struggling rural development of his own company, where it was desirable and where governors were being fitted in new houses as standard. But in certain old properties existing supplies would be inadequate if governed down, and such conditions could only be rectified as a long-term policy. Therefore, he suggested that the problem be tackled with discretion by the Regional Boards. As to the pressure differential of 2 in. over that of the governor, one appreciated the necessity for a reasonable pressure difference to make a governor work at all. But in some distribution networks considerable expenditure would have to be incurred, with little return in the way of improved service, if such a condition had to be complied with.

Therefore he suggested that a more studied approach be made to the problems before any new arbitrary standards were set up, and until time had been given to assess the cost and the effect on the consumers' service.

Dr. Smith, suggesting that there should be a move in conjunction with other bodies on the subject of education, said the Institute of Fuel had arranged with the Ministry of Fuel and Power that there should be regional education committees, which to-day were joint committees of the Institute of Fuel and the Ministry. It seemed to him a pity that the Gas Industry had not made an approach for representation on those regional education committees. Of course it could continue to work on its own; but the technical institutions and the Board of Education, in combination with the Ministry of Fuel and Power, were much more likely to support non-paying courses which covered gas engineering than they would be if the Industry were fighting alone. He suggested the matter be explored, at any rate, to see what advantages would accrue to the Industry if it collaborated with the joint education committees. Dr. Smith added that at a meeting of the Council of the Institute of Fuel he had stated, in reply to Mr. Cleave Cross, that the Institute would welcome collaboration in that way, because the Industry was of primary importance.

As to standards of gas quality, he said there was a peculiar anomaly. To-day each gas undertaking could be summoned for deficiencies in gas calorific value and pressure, and the Ministry of Fuel and Power could deal with the matter. When the Government owned the Industry, however, who would summons the Government? Who would summons the Board? Further, who would be responsible for meter testing? There would be needed an independent body; that matter needed to be settled.

On the matter of governors, he believed the Heyworth Committee, in their report, had gone a little beyond their brief. If they were going to specify things such as governors as a universal necessity, why not go a great deal further and specify what type of carbonizing plant the undertakings should use, or the type of mains? Surely it was a matter for each Regional Board to consider, having regard to the conditions in their own regions. All they needed to be told was that they must maintain the pressure to within certain limits; then they would adopt the best means available for the purpose.

Mr. J. W. Townsend (Tunbridge Wells) commented that the suggested regions might be too big and the administration too unwieldy. Particularly there should be somebody on each individual Board who could be shot at by the customers; engineers were not always sensitive to what the customer might think of the product they were sending out. There was also the question of appointing someone with technical knowledge who would control or would have some say in the matter of selling policy and the types of appliances put out on the districts. Presumably that would be covered; but it did not follow that it would.

Dr. Smith said the Regional Boards would be watching complaints, and the person whose responsibility it was to maintain satisfaction in a given area would be told if things were going wrong.

Mr. W. J. Baker (Weston-super-Mare) said that in the South-West there were 120 undertakings, only 20 of which had a capacity of more than 100 million cu.ft. per year; 50 had a capacity of less than 20 million cu.ft. per year. The South-West was undoubtedly ripe for integration and, quite frankly, it was disheartening that integration had been delayed so long. Although Dr. Smith had stated that the Ministry were doing all they could to accelerate the advancement of schemes put forward by the undertakings, Mr. Baker said that, speaking for his own undertaking, that had not been the case. He thought a good many engineers still felt that the Ministry could do a little more than they had done in the past in effecting the acceleration of schemes which the engineers considered were absolutely first class; the Ministry, of course, might have other ideas.

His personal opinion was that if the personnel and executives and the directorates and councils of undertakings knew a little more about how the Government would compensate shareholders when the Industry was regionalized, and a little more about what would happen to redundant gas engineers and managers of gas undertakings—and there would be plenty of redundant men from the smaller undertakings—it would help. What would happen to colleagues who, for age or other reasons, were not fitted for advancement in a larger undertaking in some high technical capacity? If those matters were cleared up, they would see the position more clearly.

Under the Regional Boards, according to Dr. Smith, the idea was to have a production engineer in charge of a works, and presumably a distribution engineer in charge of an area, and a service and sales engineer in charge of service to consumers. Who would co-ordinate the work of those three men in relation to the individual experts on the Regional Boards?

Col. C. M. Croft (President, Institution of Gas Engineers) proposed a vote of thanks to Dr. Smith. He added that, whatever the future of the Gas Industry, whether nationalized or not, all the members of the Institution and all in the Gas Industry would do their best in all circumstances.

The vote of thanks was seconded by **Mr. W. J. Baker** (Chairman of the Western District of the Association), and carried with acclamation.

Gas Service and Gas Quality*

By J. E. DAVIS

(South Metropolitan Gas Company)

WHAT a lot depends upon the point of view! Some 18 months ago when you were kind enough to invite me to speak to you I tried to build a bridge between two points of view—between that of the man who was developing a domestic fuel service through the agency of gas, and that of the man who was concerned with the costs of rendering this service. On the present occasion I should like to attempt a reconciliation on the subject of gas quality between the points of view of those producing gas and those selling gas.

On that earlier occasion we spoke about the demand characteristics of the various domestic loads. The gas production engineer is not concerned with these in detail, but only with their total effect in varying the amount of gas he must produce from day to day to satisfy the demands of the consumer. From his point of view the fact that there is a variation at all is a nuisance; but there are two kinds of variation, and one is a bigger nuisance than the other.

There is a variation from one part of the year to the other which is predictable. With the majority of gas undertakings it is possible to say with certainty that the average daily output during the winter period will be so many times the average daily output during the summer period. This gives a measure of the total amount of plant that must be available for work during the winter, and the amount of plant which can be made available for repair during the seasons of less heavy demand. The production engineer's calculations are, however, rendered much more difficult by the unpredictable variations which occur from day to day at any season of the year, though more in the winter than in the summer. He is fortunate, however, in that being a gas engineer and not an electrical engineer he can store his commodity, and I have thought it worth while to make an examination of some past records to see how far one may reasonably expect the gasholder to go on meeting unpredictable variations. This first function of gasholders is to meet the hour-to-hour variation in demand throughout a period of 24 hours, permitting the production plant to run along at an even load despite the variation in consumers' demands. Holder storage is used for this purpose to the greatest extent on a winter Sunday, and, in going back through the records of the 10 years preceding and including 1938, I have ascertained the greatest cumulative surplus or deficiency of make in relation to output for an individual day.

Let me explain more precisely what I mean. Assuming that the gas-producing plant is set to produce gas at a rate corresponding to the average rate of send-out, then in the early morning hours it will be producing gas more quickly than the public is taking it. There is then a surplus, and hour by hour the cumulative surplus increases. But, sometime in the middle of the morning, the position is reversed, and the public starts taking gas more quickly than it is being produced. There is then a deficiency, and the cumulative deficiency becomes greater hour by hour so long as this position continues. During the worst winter Sunday of these 10 years the cumulative deficiency reached the equivalent of 7 hours' make of gas. There were several other Sundays when the cumulative deficiency amounted to between 6 and 7 hours. Thus we see that a holder capacity equal to 7 hours' maximum make of the gas-producing plant is necessary to cover fluctuations from hour to hour during the 24 hours.

Years of experience have taught gas engineers that in designing a gasworks it is reasonable to allow about 18 hours' storage capacity, and as 7 hours of this is ear-marked for meeting the variation over one 24-hourly period, the balance of 10 to 11 hours' storage is available for meeting variations in the total output from day to day.

I have been interested to see how far this amount of holder storage could go in satisfying day-to-day variations if the rate of production were set to meet the mean daily demand of the period. First of all, I took 10-day periods and picked out those showing the greatest deviation from the mean. Holder storage of 10 hours could have dealt with all of them with one or two exceptions. There were many reasons, however, why the shorter period of 7 days is a better one to consider, and I have, therefore, worked through the daily outputs for 10 years, converting the day-by-day output figures to a series of 7-day moving averages. A 7-day moving average commences by taking the first 7 days of the year and determining the average daily output. When the 8th day is completed we drop No. 1 out of the average and include day No. 8. At the end of the 9th day we drop No. 2, and include day No. 9. It is possible to imagine a robot machine controlling gas output and working without prevision, using only the moving average of the previous 7 days. As far as I can see, such a robot could have controlled the rate of production and met the demands, provided there had always been 10 hours' holder storage available to meet day-to-day fluctuations. There are one or two exceptions. Such holiday periods as Boxing Day, August Bank Holiday, and to a less extent Easter, would have "foxed" the robot. who would have less interest in such things than a human operator, December, 1938, would have caught out the robot, who would obstinately have kept the output rate to that suitable for a mild December when it froze hard outside. With these exceptions, against the consequences of which human intelligence must guard, the robot would have managed very well, but even the robot would not have traced the same output curve in each of the 10 years.

Variations in the weather would have made the annual curves show bumps and depressions, and to meet these there must be some plant which at most times is not working to full capacity. By applying statistical methods to the 7-day averages of these 10 years a norm curve can be drawn, and on either side of this curve can be drawn other curves showing the probability of departure from the norm.

A norm curve with deviations of probability 0.02 and 0.001, in which the actual figures for each year have been related to the average daily output of the year which has been given the value of 100, shows that the robot controller would tend to travel along the norm at a level 25% above the mean for the year during the latter half of December, January, and the first part of February, and come down to 70% of the mean for the year at the August Bank Holiday period. But there is a 1 in 50 chance that on any particular day the robot may have had to depart from the norm up to the limits of the thin continuous line, and there is a 1 in 1,000 chance that it would go as far away from the norm as the thin broken line.

For most of the year the 1 in 50 and the 1 in 1,000 chances are as much below the norm as they are above the norm, but during that period of the year when severe cold spells are likely, the 1 in 1,000 chance is a much greater distance above the norm than below it. It is probable that this asymmetrical spread is due to abnormal use of appliances in very cold weather, as, for example, the use of cookers and lighting burners as supplementary space heaters. It is this 1 in 1,000 chance during the peak period that really determines the capacity of gas-making plant that must be built.

This curve has another implication. Experience suggests that for most of the year it is sufficient to provide plant immediately available to meet the 1 in 50 chance, though in the potential peak period prudence would suggest the 1 in 100 chance as representing a better working margin. Now all that amount of plant represented by the area lying between the upper 1 in 50 curve and the lower 1 in 50 curve must be maintained constantly ready for operation—even though, on the average, it produces only 50% of the gas it could produce. Thus, we see that even with gasholder storage capacity of 10 to 11 hours in excess of the 7 hours needed to meet hour-to-hour variations, there is still a definable margin of unpredictable variation that must be met by flexibility in plant output.

It is an unfortunate fact that carbonizing plant cannot be brought into action in a hurry, and the requisite flexibility cannot, therefore, be provided by putting carbonizing plant out of action or bringing it into action in the same way that a steam engine may be stopped or started; but there are three methods by which carbonizing plant can be operated to provide flexibility in output.

One method is to vary the carbonizing period, that is, the length of time for which the coal is allowed to remain in the carbonizing vessel. There are certain disadvantages attached to this method, notably the effect upon coke quality. The second, and preferable, method is to cease charging certain retorts altogether for the period that low output is required, and recommencing charging when the demand for gas increases. The retorts which are not charged with coal are said to be "standing-by," and must, of course, be maintained hot, thereby consuming coke without producing any gas. The third method, which is more easily applicable to coke ovens than to gas-making retorts, is to use a proportion of coal gas for heating the carbonizing plant, and varying this proportion according to the district demand for gas. It is a method which is only possible economically in the presence of a good market for coke.

All these three methods produce the same kind of gas at all times whatever the demand may be, and with care in operation the quality of the coal gas need show only slight variations, which are attributable mainly to variations in the character of the coal received.

In the South Metropolitan Gas Company we employ the "stand-by" method, which does involve quite considerable cost in burning coke to keep the settings hot when they are not gas-making, and in keeping a sufficient reserve of labour available against increases in demand. The practice is sometimes criticized on these grounds, but from our experience I can say that the average cost spread over the total therms made in a year is considerably less than might be imagined.

To avoid the loss of fuel and manpower which is undoubtedly associated with "stand-by" work, methods are used involving gas-making processes other than carbonization and producing gas of a

* Paper to the London and Southern District Junior Gas Association.

different kind. I will mention two systems. That which is the more popular makes use of carburetted water gas plant, which has the advantage that it can be brought into action from cold in a matter of a few hours and does not require a large labour force to operate it. Compared with coal gas it is more costly to produce on a steady load, but the cost may be no higher, or even less than that of coal gas for marginal production on short period peaks. It is unfortunate that a gas-making process having such merits in respect of flexibility yields a gas of marked difference in composition and properties from coal gas.

The second method may be described as one of variable dilution. It is to-day a fairly common practice to produce coal gas having a higher calorific value than the declared calorific value, and to dilute that gas down to the declared calorific value by the addition, under control, of a diluent gas. There are three gases normally available—waste gas, producer gas, and blue water gas—and for the purpose of illustration we may assume that undiluted coal gas, debenzolized, has a calorific value of 560 B.Th.U. per cu.ft., while the declared calorific value to be supplied is 500 B.Th.U. per cu.ft. Waste gas has no calorific value, and dilution involves the admixture of 12 volumes of waste gas with 100 volumes of coal gas, giving a total of 112 volumes of the mixed gas at 500 B.Th.U. per cu.ft. Producer gas may be taken as having a calorific value of 130 B.Th.U. per cu.ft., so we may add rather more of this than we could of waste gas, the total volume of the mixture being 116 volumes per 100 volumes of coal gas. Blue water gas, with a calorific value of 295 B.Th.U. per cu.ft., can be added in still greater quantity, giving a total volume of mixture of 129 volumes per 100 volumes of coal gas. By varying the nature of the diluent gas we can get a 15% variation in output for a constant production of coal gas.

Of course, this is not done without some change in composition of the finished gas. With waste gas we are adding nitrogen and carbon dioxide; with producer gas we are adding nitrogen, carbon dioxide and carbon monoxide, and with blue water gas we are adding hydrogen and carbon monoxide. Taking the example we have used for the purpose of illustration, and assuming that the undiluted coal gas has a specific gravity of 0.363, dilution with waste gas would give a final specific gravity of 0.440, with producer gas 0.437, and with blue water gas 0.405.

No doubt the utilization engineer would prefer to receive at all times a gas of identical composition, because he will claim that he could then guarantee identical performance at all times of all the appliances in his charge. I should like to suggest that this guarantee would have to be subject to certain qualifications; and I would suggest further, that because the variations in demand come from the district, it is reasonable to see how far the district can help the works in accepting variations in quality to facilitate the meeting of variations in demand.

We are all aware of the very considerable discussion that there has been in recent years on combustion characteristics, which are always felt to be of prime importance when viewed from the district angle, and a most irksome restriction from the works angle. I believe that the work which has been done on combustion diagrams enables us now to see the subject in reasonable perspective.

Experiment and experience show that there are two danger areas—the lighting-back area, and the area of luminosity, that is, of extreme under-aeration. Between the two there is a safe channel wherein gas burners will give satisfactory performance. Now, in practice, the channel is not so sharply defined. Unavoidable variations do occur from hour to hour and day to day in the composition of the gas, and they make the margins of this channel rather like tidal beaches for the purpose of navigation. We know the limits are about the position of these lines, but the exact position is less clearly defined. The same is true of the ships which navigate the channel—that is, the gas appliances on the district. A perfectly adjusted burner would, of course, follow its central line through the channel and there would be little to worry about; but in practice we are not dealing with a single appliance, with the single ship on the perfect course, but rather with a convoy of ships—appliances which have been adjusted within practical limits of tolerance, and have been maintained within practical limits—and the convoy may be somewhat straggly. This is the reason why a change in the gas quality is not equally apparent on all the appliances on the district. Some may give trouble, but many will still work satisfactorily. If the channel narrows, the worst stragglers will be the first to go on the rocks, and those nearest to the perfect course will have the best chance of coming through safely.

With any one gas the ease of navigation would be greater with some types of burner than with others. Equally for any given burner some types of gas are easier to deal with than others; but with all burners and with all types of gas a satisfactory adjustment for the satisfactory course is possible. There is one exception—the inverted lighting burner. Given sufficient accuracy in adjustment and given sufficient care in maintenance, any commercial burner can be adjusted to any probable gas composition; though the less tolerant the burner, or the less tolerant the gas, the more necessary it will be to maintain the composition of the gas within narrow limits, and to ensure a higher degree of maintenance and accuracy of burner adjustment.

So we arrive at the point where production and utilization must reach a compromise. Production should aim at supplying a gas which has reasonable tolerance—that is, a fairly wide safe channel.

In the design of appliances the aim should be to produce a burner which is tolerant.

I realize that there are some people who feel that the problems of combustion characteristics can be avoided or reduced in importance by the use of burners which are not aerated prior to the point of combustion. (I would rather not say whether such flames should be called "neat" gas or "all-gas.") These burners have been shown to be much less affected by variations in gas composition than are aerated burners, but there is one overriding consideration demanded by good service, whether the burners we use are aerated or not, and that is the maintenance of the thermal input to the appliance.

A gas appliance will operate with little change in thermal efficiency over quite a wide range of thermal input, but the performance cannot possibly be the same throughout the range.

A gas fire with a thermal input of 15,000 B.Th.U. per hour and a radiant efficiency of 47% will emit just over 7,000 B.Th.U. per hour to the room. If we drop the thermal input by, say, 15%, the radiant efficiency may still be 47%, but the heat input to the room will be less than 6,000 B.Th.U. per hour. Similarly, with an instantaneous water heater, which may have a thermal efficiency of 80% and maintain this efficiency over quite a wide range of thermal input, the appliance is adjusted, shall we say, to give a rise of 90°F. in the water flowing through it. If the inlet water temperature is 50°F., the output will be 140°F. A reduction of the thermal input by 15% will bring the temperature rise to 76°F., and the outlet water temperature will then be 126°F., provided the inlet water temperature is still 50°F. But suppose that the thermal input is reduced at a time when the weather is very cold, and the inlet water to the instantaneous heater is taken from a roof storage tank where the temperature is only a couple of degrees above freezing point, then the outlet water temperature will only be 110°F., and the hot bath may not be a hot bath any longer.

It is the importance of thermal input and its consequences to appliance performance which give so much interest to the Wobbe Index. It is true that it is a German idea, but it is a lot better than some ideas coming from that country. If we refer back for a moment to the method of adjusting output by altering the type of dilution gas, we find that the Wobbe Index varies as between dilution by waste gas and by blue water gas only by some 4%—a difference which could certainly not be detected in practical performance. But the difference between coal gas diluted with blue water gas and carburetted water gas is about 20%. Of course, I would not suggest that anyone on the production side would contemplate such a drastic change as is involved in this 20%, but I do believe that we must watch the Wobbe Index because of its overriding importance to the performance of gas appliances. Moreover, I think we shall find that if we have been wise in selecting tolerant appliances and a tolerant gas composition, combustion characteristics can then in large measure be left to look after themselves.

Finally, there does arise one interesting speculation. To what extent may it become desirable, in the future, deliberately to alter the Wobbe Index, either by lowering the specific gravity or by raising the calorific value, to meet peak demands for heat in the coldest weather? I know that suggestion is not original; but I believe there is a lot in it.

Bridge Collapse at Darwen

A bridge 100 ft. long carrying a 20-in. main and other pipes across a disused mill lodge from the retort house to the condensers at Darwen (Lancs) collapsed 30 ft. to the bed of the lodge last Thurday morning, severing the pipes and cutting off the town's supply.

Faced with the immediate task of restoring the supply, Mr. J. Pollard, Engineer and Manager, decided to take the mains down to the level of the bed, run them across the bottom of the lodge and up the other side. Forty men worked on the job, and in 19 hours the trunk main, power and liquor mains and steam main were connected up and the gas supply was restored. The operation entailed the erection of a large number of supports to carry the mains along the bed, and in addition a lot of digging was necessary to get the correct level before the pipes could be connected up. It is hoped that the emergency repairs will serve their purpose until another bridge can be built.

Waverley Association of Gas Managers

The Waverley Association of Gas Managers are holding their Annual Meeting in the Y.M.C.A. Hall, 14, South Street, Andrew Street, Edinburgh, on Friday, June 21, 1946, at 10.30 a.m., when the President, Mr. Harold Robinson, Engineer and Manager, Annan, will take the Chair and deliver his Presidential Address. Thereafter the Members will have Lunch in the North British Station Hotel, Princes Street. On the previous day, Thursday, June 20, Golf and Bowling Competitions will take place.

Reactions in the Retort*

and their Influence on the Nature and Yield of the Products of Carbonization

By S. R. ILLINGWORTH, D.Sc., F.I.C., A.R.C.Sc.
(Denbighshire Technical College)

CARBONIZATION of coal is a time-temperature chemical change, namely, one influenced by the operative temperatures and the period to which the coal is subjected to such temperatures. It is further influenced by the nature of the coal, the character of the retort, the thickness of the charge, &c. Consideration of the changes involved requires a general outline of the main characteristics of coal.

The general analysis of coal utilized in the Gas Industry is confined to the proximate analysis, augmented in many cases by small scale tests as to yields from certain deliveries of coal. The determination of volatile in the proximate analysis is, so to speak, an "end-point" figure, since such is determined at optimum temperatures for the complete elimination of the volatile as speedily as possible. Coal is a mixture of substances, each of which responds to temperature effects in a particular manner. Valuable information results from the exploration of the influence of temperature on the amounts, the nature and the rate at which products are evolved from coals at various stages in the process of carbonization.

Evolution of Volatiles

The volatile from coal is evolved in stages; at each temperature, no matter how much longer the heating be continued, there is an optimum evolution of volatile at that particular point; further devolatilization demands operation at some higher temperature. The amount of volatile at any given temperature varies with the type of coal; as an approximation it can be stated that the higher the total volatile of the coal the greater is the amount evolved in the early stages of carbonization, say over the temperature range 350° to 450°C.

No. 2 Llantwit high volatile bituminous coal evolves some 12% volatile at 350°C., a figure that is under 1% for the other coals treated. The term "thermal stability" is conveniently used to define the ease with which coal is devolatilized by heat. Coals, such as the Llantwit, which lose the major part of their volatile at low temperature (say, under 400°C.), are of low stability; anthracites by contrast are of high stability, since the small amount of volatile requires temperatures around 700°C. before it be evolved. There is a general similarity of behaviour of the residues obtained at 600 when they are further heated to higher temperatures; in general all coals leave a residue at 600, which evolves a further 8% volatile at 900.

The gas type of coals give up their volatile mostly in the range 350 to 400 to an extent generally definable by subtracting 8 from the total volatile of the coal, in other words some 75% of the average 35 volatile of gas coals is evolved from substances decomposed below 400° C.

Extraction Under Pressure

The extraction of coal with solvents, such as pyridine, phenol, tetralin, benzene, under pressure, &c., results in its division into three main types of components, which are of interest in the study of carbonization.

The Alpha component is the insoluble residue. In general type it is not much different from the coal. It is of high thermal stability, decomposing with production of little tar, but considerable volume of a water type gas rich in hydrogen and carbon monoxide.

The Beta component is the portion soluble in phenol, &c., but insoluble in benzene. In contrast to the coal it is of lower carbon and hydrogen content, but much richer in oxygen. It decomposes at low temperatures, with production of much liquor, little neutral oil, considerable phenolic substances (resinoids), and a weak gas containing much carbon dioxide.

The Gamma component is remarkable for the higher hydrogen content, the fact that it melts or softens and gives rise at low temperatures to high yield of tar rich in neutral oils of a non-aromatic nature. The gas from this component is of exceptionally high calorific value, some 850 and upwards B.Th.U. due to the presence of hydrocarbons, ethylene, &c. The gamma compound can be regarded as the caking agent in coal, since it fluxes into the charge in its vicinity and subsequently binds it by a carbon skeleton when decomposed at higher temperatures.

Coal in the process of carbonization passes through all temperatures from normal climatic conditions up to the optimum operative temperature. Clearly, the initial stages are concerned with the evolution of volatile matter from the less stable beta and gamma component, the amounts of which condition the lower nodal point of coals. They give rise to products, gas and tars, totally different in character from those that are ultimately produced in normal high temperature carbonization. The initial or primary volatile products are converted into the high temperature products by changes within the retort. The final character and yields of the products are dependent on the extent to which these secondary changes result—one may say dependent upon the time-temperature condition of the operation. The time-temperature condition can be expressed in terms of the temperature gradient within the charge.

The time-temperature factor is concerned with the mutual effect of flue temperatures in relation to thickness of charge. Clearly, with thin charges the whole will come to 800°C. the more rapidly; this latter temperature can be taken as the average point of the initiation of the secondary changes. The time factor of influence is bound up with the path taken by the volatile products in their esca pefrom the charge and out of the retort; this factor is conditioned by the establishment of a plastic layer in the charge. The layer commences to be formed the moment the outer or wall side portion of the charge reaches a sufficiently high temperature (300°C.) to cause liquation of the gamma compound and its absorption into the adjacent layers of the charge; the layer on further rise of temperature undergoes carbonization and is converted to coke. It advances inwards toward the centre of the charge in step with the temperature gradient. The thickness and robustness of the plastic layer is conditioned by the caking index of the coal. High values of the index denote considerable content of the cementing material (gamma). With high caking index coal the resistance set up by the plastic layer forces the gases to seek escape back towards the walls of the retort—*i.e.*, to pass through the portions of the charge at the higher temperatures and most likely to pass along the surface of the hot retort walls. With the less strongly caking coals the pressures generated in the evolution of volatile matter overcome the resistance of the plastic layer, the gaseous products pass in part into the central portions of the charge, and other sections find their way back through the hotter layers of coke towards the walls.

Influence of Design

The path of the gaseous products is further influenced by the design of the retort—a factor that is returned to after consideration of the main features of the products obtainable from a coal under low temperature and high temperature conditions, and of the manner in which the former are changed to the normal types of high temperature products in their escape from the retort. The term "pyrolysis" is applied to the changes effected by thermal influences. Pyrolysis of the initial volatile products is accompanied by a type of polymerization that is a subsequent building up of heavier constituents from the breakdown products of the initial volatile matters evolved.

The general differences in the results of carbonizing the same coal under low and high temperature conditions are as follows:

Gas:	Carbonization at 450° C.	Carbonization at 1,000° C.
Yield	3,500 cu.ft.	11,000 cu.ft.
Hydrogen	20%	50%
Methane	60%	40%
Unsaturated Hydrocarbons	5%	1 to 3%
Higher Paraffins	*circa* 5%	*nil*
Aromatic Hydrocarbons	*nil*	1½%
Calorific value	*circa* 850 B.Th.U. upwards.	Calorific value 500 B.Th.U.

Tars—7% by weight.	Carbonization at 450° C.	Carbonization at 1,000° C.
		4% by weight.
Specific Gravity	1.05	1.1 to 1.2.
Mainly Naphthalenes as the neutral Oils		Aromatic Hydrocarbons, Naphthalenes, Anthracenes.
Low Phenol content Ch. Resinoids and Creosols		Phenols and Creosols.
Pitch above 320°	40%	Pitch 66%

The increase of gas at the higher temperatures arises in part from the decomposition of the portions of the coal (or derivatives therefrom) that require higher temperatures to effect the change; more particularly these are the components that give rise to the upper nodal point of coals. The major contribution to the greater volume of gas is

* Lecture to the Wales and Monmouthshire Association of Gas Engineers and Managers, May 9.

concerned with the pyrolysis of the tars, which are dehydrogenated by the higher temperatures into aromatic hydrocarbons with evolution of hydrogen. The increase of gas volume arises from dilution of low-temperature gas by the hydrogen produced. At the same time the higher paraffin hydrocarbons of the gas are pyrolized to aromatic hydrocarbons through the intermediate formation of ethylenic hydrocarbons.

The General Picture

The initial low-temperature tars suffer considerable degradation to carbon, and undergo polymerization into aromatic hydrocarbons that constitute the heavier or pitch fraction of the high-temperature products. The production of carbon in the process is indicated by the higher content of free carbon in the high-temperature tars and its general absence in low-temperature tars.

The general picture of the happenings in the retort can be summed up in the view that the nature of the products from high-temperature operations is the result of the extent to which the initial products of decomposition are changed in the course of their passage from their point of evolution to final escape from the influence of elevated temperatures. In addition to the influences of the caking index of the coal and the operative temperatures, the size of coal used modifies the travel and rate of evolution of volatile matters. The larger the coal employed the greater the chances of free escape of the volatile through the cooler sections of the charge, and the consequent production of higher yields of the lower density tars.

The path of the volatile products differs in the three main type of carbonizing plant in general use in the Industry. Horizontal ovens are substantially heated on all sides; carbonization proceeds from the whole of the surface of the charge towards the centre. In consequence of the absence of an inner cool path of escape, the secondary reactions on the volatiles are practically complete. The tars are of an aromatic character, and higher in density and pitch content than the tars from the other forms of retort. Continuous verticals are characterized by the central cool cone in the upper section of the retort. This provides a cool escape for volatile products, particularly when coals of low swelling character and of nut sizes are in use. The methane content of the gas tends to be high, and the absence of contact of the volatiles with very hot surfaces precludes their stage-wise pyrolysis and polymerization to heavy aromatic hydrocarbons, such as naphthalene, anthracene. The vertical retort tars are of lower density than horizontal tars, their content of lighter oils is higher, pitch content is lower, and the benzoles carry a greater amount of naphthenes. The chamber type of verticals result in the presence of a cooler central zone that extends across the centre of the retort parallel to the flue walls; their charge is generally coals of the finer sizes; their tars tend to be intermediate between the horizontal and continuous vertical types, since the less porous mature of the charge tends to force a considerable portion of the volatiles back towards the retort walls, and thus cause a greater degree of pyrolysis than with the continuous retorts.

Formation of Coke

The factors discussed in relation to tars and gas have an equal influence on the nature of the coke. The formation of coke can be pictured as follows. The gamma or cementing material softens at or around 300°C., and sets up a plastic layer in the charge of greater or lesser extent, dependent on the caking index; with rise of temperature this layer suffers devolatilization at a rate dependent on the temperature gradient in the retort. A stage is reached with the successive advance of the plastic layer towards the centre of the charge when a part of the layer is in a viscous state; volatile matters here evolved distend this section in a manner akin to the action of a yeast. The degree of distension or swelling is conditioned by the amount of viscous material and the rate at which the volatile matters are evolved. The higher the caking index of the coal in general the greater is the swelling of the charge. The structure of the coke formed below 500°C. is fixed when the further carbonization of the viscous layer destroys the gamma constituent.

The porosity of coke has influence on its combustibility, but such is moderated by subsequent happenings in the retort, the more particularly concerned with the pyrolysis of the volatiles and the final temperatures to which the coke is subjected. A simple method for determination of the relative combustibilities of coke is to support a 1-in. cube of the sample on a nichrome wire stand held in a silica dish. The coke is weighed after drying it at 100°, the assemblage is weighed and then placed in a muffle at a desired temperature (such as 500°C.), through which a current of air is constantly drawn in an amount twice that required to burn the coke in three hours. The loss of weight at set intervals of time defines the combustibility.

With increase of temperature the combustibility decreases. The higher the temperature and the more exposed the coke to the action of volatile products, the lesser its combustibility through the process of graphitization or "silvering" that arises by the deposition of carbon of graphitic character within the coke.

The generally superior combustibility of continuous vertical coke as compared to horizontal cokes is explainable on the absence of graphitization due to the volatiles having free escape along cooler paths. In high temperature practice at and above 750°C. the coke structure formed at and around 450 undergoes a change that results in its contraction—an important point in regard to the ready discharge of intermittent verticals. This change naturally brings about an increase in density of the coke. The final character of the coke is conditioned by the same factors that influence the nature and yield of the gas and tars; such influences can be further modified by alteration of the character of the charge by external methods of blending coal to suit particular ends.

In the blending of coals of different swelling capacities by suitable adjustment of quantities of the various coals any desired degree of expansion can be achieved. In other words, the behaviour of the charge in the retort during its passage through the plastic stages is controllable. In consequence the degree of pyrolysis of the volatiles is alterable and the general character of all the products is affected. The coke from blends is of denser character; it is more combustible, carbonization is speeded up, and a higher yield of lower gravity tars and a richer gas results.

DISCUSSION

The **President** (Mr. O. P. Cronshaw) said Dr. Illingworth had spent a lot of time not only in his present position at Wrexham College, but in the scientific side of carbonization. He had been on the structural side of low-temperature carbonization and knew his subject. Having listened with interest to his lecture, he could only say that they were all looking forward to the time when they could get coals they could blend and use to the best advantage.

Mr. **W. Clark Jackson** (Neath) said they had in their own simple way carried out certain experimental work connected with South Wales coals, and they could, from those experiments, confirm what the Author had put before them. They had vertical retorts and worked South Wales coals, and they found they could get far better results, both from the gas-making and coke-making point of view, by blending. They had been successful in obtaining the co-operation of certain of the collieries in South Wales—most of which were years behind the collieries in Yorkshire and other districts, where coals were cleaned, sized, and washed—whereby they were able to buy 3-in. washed coals, fines extracted. They got plenty of smaller stuff, below 1½ in., and that meant they had to look out for something else in their mixtures to get the best results. They did that by mixing in during the discharge of their coals a certain amount of large coal of the same type as they had supplied as washed through. They got some very large coal and mixed it in as a blended mixture, and they achieved first class results from the gas-making point of view, and from the point of view of the structure and combustibility of the coke. To the younger men in the Industry Dr. Illingworth's Paper would be of great service, for it was to the younger men that they looked for still further efficiencies and economies in the carbonization of coal. The high cost of coal and labour in the smaller works had been referred to, and it was only by increasing the efficiency of man-power per ton of coal put through that they could hope to get the cost of production to a reasonable level. The Paper had given them a great deal of information on the actual handling of their retort installations in such a manner as would improve the efficiency of their gas-making and coke structure.

Major **E. Ivor David,** Regional Gas Officer, said it was strange that gas-making processes could be carried out at temperatures considerably below those at which it was possible economically to operate continuous verticals or intermittents. Such plant worked up to 1,300°C., and yet gas-making processes could be carried out at or below 900°C. Another important point was the time taken in the drying of coals. It appeared that at present they wasted 12 hours of valuable plant time in drying out the water, part at least of which could have been removed in plant which had a much lower cost per ton of throughput than the carbonizing plant. An enormous amount of money had been spent on coal preparation apparatus at the collieries, but due to the deterioration in the class of coal sent up by the miners—one excuse for which was the development of machine mining—they had coal sent to the cleaning plant which it was almost impossible to clean thoroughly. Washing, froth flotation of fines and coagulation of slurries had all been practised, but those efforts were nullified if the coal was so dirty that the plant was choked by the amount of dirt discharged, and that was the trouble that the collieries had to face. In the last three years another hindrance had developed as the result of the water infusion methods carried out underground to meet the dust problem. It was to be hoped that under the new dispensation more money would be spent on coal preparation so that consumers could have the product they could use economically.

Dr. **Illingworth** said that the use of very high flue temperatures was a question of sheer cussedness. The trouble was that the rate at which anything could be done was the driving force divided by the resistance. Coal was a very poor conductor of heat, and the bricks of which the plant was constructed were relatively merely insulators. In order to establish a reasonable temperature gradient through the charge and get carbonization effected in a reasonable time a very high driving force—high temperature—had to be used in the chamber. With regard to water, they had to have a considerable amount of water

in the charge to temper down the temperature, otherwise if they used completely dry coal the coke would lack the necessary robustness. Major David was a fighter, and he wished him luck in taking up the cudgels on behalf of the mining industry.

Mr. **H. B. Kendrick** (Conway) said he was fortunate some years ago in being able to conduct experiments on vertical retorts on similar lines to those conducted by Dr. Illingworth, and they were struck by the power of the plastic layer to prevent gas from the two zones intermixing. They proved their theory pretty conclusively by taking continuous samples from the hot zone and from the cool zones, and from an analysis they tried to estimate the quantity of gas passing up the two zones, and it was found to be somewhere in the region of two volumes of gas from the hot zones to one from the cool zone. Addition of breeze to the coal with the idea of making the plastic layer less homogeneous was tried but did not prove satisfactory, and so far as he knew no satisfactory method had been found to speed up the plastic layer. It was a point in which the Gas Industry had not been sufficiently interested. Had the Author any suggestions on that point; also could he offer any suggestions for controlling the amounts of the alpha and beta compounds?

Dr. **Illingworth** said that the only solution to the first problem was a two-stage process. It could not be done in one retort. There had been many attempts, and one endeavour was to carbonize sideways, by continuous working only heating on one side and drawing the gas into a central chamber. In answer to the second point, the amounts of alpha and beta compounds in coal were put there by Nature, and they could only be controlled by Nature.

Mr. **E. M. Edwards** (Port Talbot) said that as a student he had listened with great pleasure to a master of his subject, and certain vital thoughts had arisen. The first was how little they knew of their basic raw material, coal, and the second was how limited was the application of the scientific knowledge they had to the treatment of that raw coal in the Gas Industry. The gas engineer and manager had to be a man of many parts, and could not hope to be a specialist in all directions. Looking ahead to modernization and to the probable erection in many cases of centralized improved manufacturing plant, he thought they should clearly make provision for the adequate staffing of such modernized works with scientists in addition to the normal gas engineers, who could suggest and devise the most suitable manner of dealing with their raw coal. To-day coal was carbonized in many works of different sizes, and there was in the great majority only a very limited scientific treatment of the coal. In their plans for the future they should bear in mind that the Gas Industry as such did not make sufficient use of the scientists who were available to assist in the better treatment of coal.

Dr. **W. T. K. Braunholtz,** Secretary of the Institution of Gas Engineers, said he had known Dr. Illingworth for many years, and had had the privilege of discussing with him some of the problems mentioned in his Paper. There were two points on which more emphasis might be laid. One was the possibilities of blending, not merely mixing, but scientific blending in carefully controlled proportions. That was common practice in coke oven installations, and it seemed that more could be done in that direction by the Gas Industry. There were certain practical difficulties in the Gas Industry which were not present in the coking industry which had prevented the development of blending, but he would have liked to hear a little more from the Author of the way in which the rate of carbonization, the quality of the gas, coke, and by-products, could all be controlled by adjusting the proportions of the various constituents of coal blends. Coal blending might not be a practical proposition at a large number of gas-works, particularly in the case of smaller works, but surely something could be done in the way of blending by the collieries themselves. He was assuming conditions in which gas undertakings could purchase the coal they required. Under ideal conditions collieries would be able to give a specified guaranteed blend to suit particular conditions. There had been suggestions in the past for centralized blending plants, but he did not think they had ever gone very far. He suggested very strongly that as soon as times became a little more normal the whole question of blending should be considered very carefully by the Gas Industry. He second point was the influence of ash on the carbonizing process. Before the war a very interesting experiment was carried out at Tottenham in which they carbonized some of their normal coal, and also some coal in which the percentage of ash had been greatly reduced, and the published results showed some striking effects on the quantity and quality of the by-products and on the rate of carbonization. The Gas Research Board had on its programme, as soon as it could get to it, work on the full-scale carbonization of coal which had been cleaned down to its inherent ash.

Dr. **Illingworth** said the whole question of carbonization was concerned with the plastic layer, and the plastic layer was weakened by blending. In regard to ash, it was an extraordinary thing that all the effects of natural chemical changes were influenced by catalysts. If they carried out small scale tests on 2 cwt. of coal, using stainless steel, silica, and cast iron retorts under identical conditions, they got quite different results. It was quite clear that certain ash constituents were negative catalysts, causing the break-up of the hydrocarbons to be too virulent.

A vote of thanks was accorded to the Author on the proposition of Mr. D. Muir (Pontypridd), seconded by Mr. Owen Evans (Wrexham), to which Dr. Illingworth briefly replied.

London Juniors' Annual Meeting

The annual general meeting of the London and Southern District Junior Gas Association was held on May 17 at Gas Industry House, under the Presidency of Mr. L. W. ANDREW (Gas Light and Coke Company).

The financial statement for the past year was presented by the HON. TREASURER (Mr. S. J. Gibbons). The accounts were adopted on the proposition of Mr. E. W. B. DUNNING (Gas Light and Coke), seconded by Mr. A. W. PENNY (Barnet).

A brief report on the activities of the Association during the past session was given by the PRESIDENT. Nine meetings had been held, with an average attendance of 100 members. The standard of the Papers read had been commendably high, and he was delighted to be able to announce that three of these had received awards. Mr. L. J. Clark (Gas Light and Coke) had received the Milbourne Medal for his Paper on "Boosting," the S.B.G.I. Medal had been awarded to Mr. A. E. Livett for his Paper entitled "Bread Baking," and Mr. D. Beavis (Cambridge) had been awarded the Charles Hart Memorial Medal for the best Paper in the Diploma Examination, Gas Engineering (Manufacture). Two visits, one to Beckton and one to Watson House, had been marked by excellent attendances, and he wished to extend thanks to the Gas Light and Coke Company, who had arranged them. He was happy that Mr. J. E. Gray (Gas Light and Coke) was continuing in his office of Hon. Secretary for the forthcoming session, and he paid tribute to his valuable work in the service of the Association. He also extended his thanks to Mr. T. V. Garrud (Gas Light and Coke) and Mr. C. A. Deas (Tottenham) for their work on the Convention. He concluded by wishing every success to Mr. G. G. Warne, who became President in his place.

The adoption of the President's report was moved by Mr. G. G. WARNE (Portsmouth), who presented Mr. Andrew with an illuminated address, and was seconded by Mr. F. C. SMITH (Gas Light and Coke), and unanimously agreed.

A vote of thanks was accorded to the Officers and Council for their services during the Session, on the proposition of Mr. J. E. COOPER (Gas Light and Coke), seconded by Mr. LE MOINE (South Metropolitan).

The following Officers and Council were then elected for the Session 1946–47:

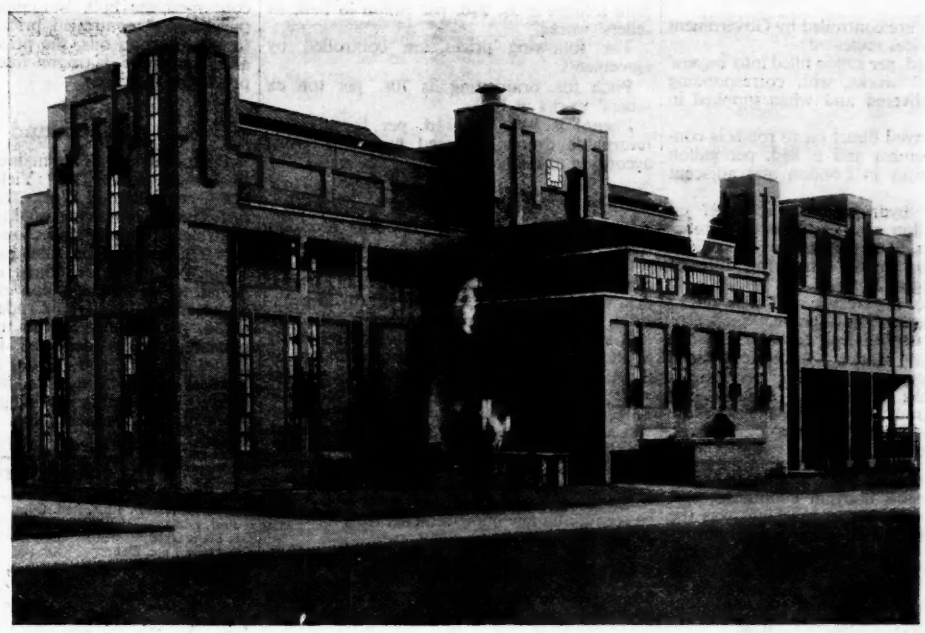
President: Mr. G. G. Warne (Portsmouth). *Senior Vice-President:* Mr. C. A. Deas (Tottenham). *Junior Vice-President:* Mr. L. J. Clark (Gas Light and Coke). *Hon. Treasurer:* Mr. S. J. Gibbons (Gas Light and Coke). *Hon. Auditor:* Mr. G. Wilson-Smith (Gas Light and Coke). *Hon. Secretary:* Mr. J. E. Gray (Gas Light and Coke). *Hon. Asst. Secretary:* Mr. W. F. Pritchard (Tottenham). *Council:* J. H. C. Bates (Brighton, Hove and Worthing), H. R. Hart (North Middlesex), W. Johnson (Wandsworth), C. D. Pressley (Dover), L. F. Randall (South Metropolitan), A. H. Savill (Wandsworth), C. D. J. Woodall (Rochester, Chatham and Gillingham), J. E. Cooper, T. V. Garrud, R. N. Le Fevre, F. C. Smith (Gas Light and Coke). *Ex-officio Members:* J. M. Webber, F. Dawson (Southern Association of Gas Engineers and Managers), R. F. Twist, L. W. Andrew (Past-Presidents). *Representatives to serve on the District Education Committee:* G. G. Warne, C. A. Deas, R. F. Twist, J. E. Gray.

The appointments were proposed by Mr. B. W. DAWKINS (Gas Light and Coke), and seconded by Mr. L. J. SMART (Gas Light and Coke).

A vote of thanks to the Technical Press was accorded on the proposition of Mr. J. E. GRAY, seconded by Mr. R. N. LE FEVRE.

Two discussions followed. The first of these dealt with a suggested amendment to the existing rules governing the qualifications necessary for membership of the Association. Hitherto manufacturers had been excluded from membership but, after several members had expressed their opinions, it was unanimously decided that the Rules Committee should make the necessary arrangements to admit a wider circle of members. The second discussion was concerned with the desirability of mid-week afternoon meetings. The question proved to be a ticklish one and a lively discussion arose, the country members pleading for an hour early enough to enable them to reach home without difficulty, and many London members doubting their ability to obtain leave from work to attend an afternoon meeting. As the country members were in the minority it was obviously unfair to take a vote on the issue, and the matter was left for later discussion, many being in favour of meetings at varied times.

Following the business, a cinematograph film was shown entitled "Steam." Commencing with a pictorial account of the development of water-tube boiler design and its attendant increases in pressure with reduced coal consumption, the film showed by means of close-ups the construction and operation of a modern power station boiler. Various shots showed the manufacture of many of the products of Messrs. Babcock & Wilcox, Ltd. (by whom the film was loaned), and the film ended with the loading and shipping to site of the completed apparatus and its subsequent erection.



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